Non-Linear Optimisation

- **Manufacturing Problem**
- **Compression Problem**

Reference:

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Problem 1:
A manufacturing firm producing small refrigerators has entered into a contract to supply 50 refrigerators at the end of the first month, 50 at the end of the second month, and 50 at the end of the third. The cost of producing x refrigerators in any month is given by $(x^2 + 1000).The firm can produce more refrigerators in any month and carry them to a subsequent month. However, it costs $20 per unit for any refrigerator carried over from one month to the next. Assuming that there is no initial inventory, determine the number of refrigerators to be produced in each month to minimize the total cost.

Mathematical Formulation (Problem 1):

Let x1, x2, and x3 represent the number of refrigerators produced in the
First, second, and third month, respectively. The total cost to be minimized is given by
Total cost = production cost + holding cost
Or
$f(x1, x2, x3) = (x1^2 + 1000) + (x2^2 + 1000) + (x3^2 + 1000) + 20(x1 - 50) + 20(x1 + x2 - 100)$
$= x1^2 + x2^2 + x3^2 + 40x1 + 20x2$
Subject to constraints:
X1>=50
X2>=50
X3>=50

How to use the code (Problem 1):
The code uses three variables and the vector having lower and upper bounds are already initialized**. The user just needs to simply, run the code** and in case of different values for vectors, one can edit x1 and x2 in source code.

Problem 2:
In a two stage compressor, the working gas leaving the first stage of compression is cooled (by passing in through a heat exchanger) before it enters the second stage of compression to increase the efficiency. The total work input to a compressor (W) for an ideal gas, for isentropic compression, is given by
W=CpT[(p3/p1)^(k-1/k)+(p2/p1)^(k-1/k)-2]

Where Cp is the specific heat of the gas at constant pressure, k is the ratio of specific heat at the constant pressure to that at constant volume of the gas, and T is the temperature at which the gas enters the compressor. Find the pressure in the compressor. Also, determine the minimum work done on the compressor.

Mathematical Formulation (Problem 2):

Taking x1,x2,x3 as the pressure values as the specific heat of the gas at constant pressure and T1 is the temperature, we get,

```
y=C*T1*(((x(3)/x(1))^(k-1/k))-2+(x(2)/x(1))^(k-1/k))
```

where lower bound vector contains the minimum values of pressure and upper bound vector contains the maximum values of pressure.

How to use the code (Problem 2) :

As the user clicks on the execute button, the console gets displayed.
The user is asked to take the following steps:

- Enter the value of Specific heat at constant pressure for a chosen gas. For the problem taken, it is **23.**
- Now, enter the temperature (in Kelvin). Here, the temperature used is **123 K**.
- Enter the ratio of Specific heat of the gas at constant pressure (Cp) to the of Specific heat of the gas at constant Volume(Cv). Here, it is **4.5**.
- As one enters the value, the function is called and the output is displayed on the screen.

About the function:

```
[xopt,fopt,exitflag,output,lambda]=fminbnd(f,x1,x2)
```

Input Parameters
f : A function, representing the objective function of the problem.
x1 :A vector, containing the lower bound of the variables of size (1 X n) or (n X 1) where n is number of variables. If it is empty it means that the lower bound is empty.
X2: A vector, containing the upper bound of the variables of size (1 X n) or (n X 1) or (0 X 0) where n is the number of variables. If it is empty it means that the upper bound is empty .